Atmospheric Fluctuation Measurements with the Palomar Testbed Interferometer

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and the PTI collaboration

Data Analysis

Used data from the Palomar Testbed Interferometer

- **single 110 m baseline**
- **2.2 microns observing wavelength (2.0 - 2.4 μm band)**

Delay line metrology values (10 or 20 msec intervals)

- **Tracks the interferometer delay on timescales >100 msec**

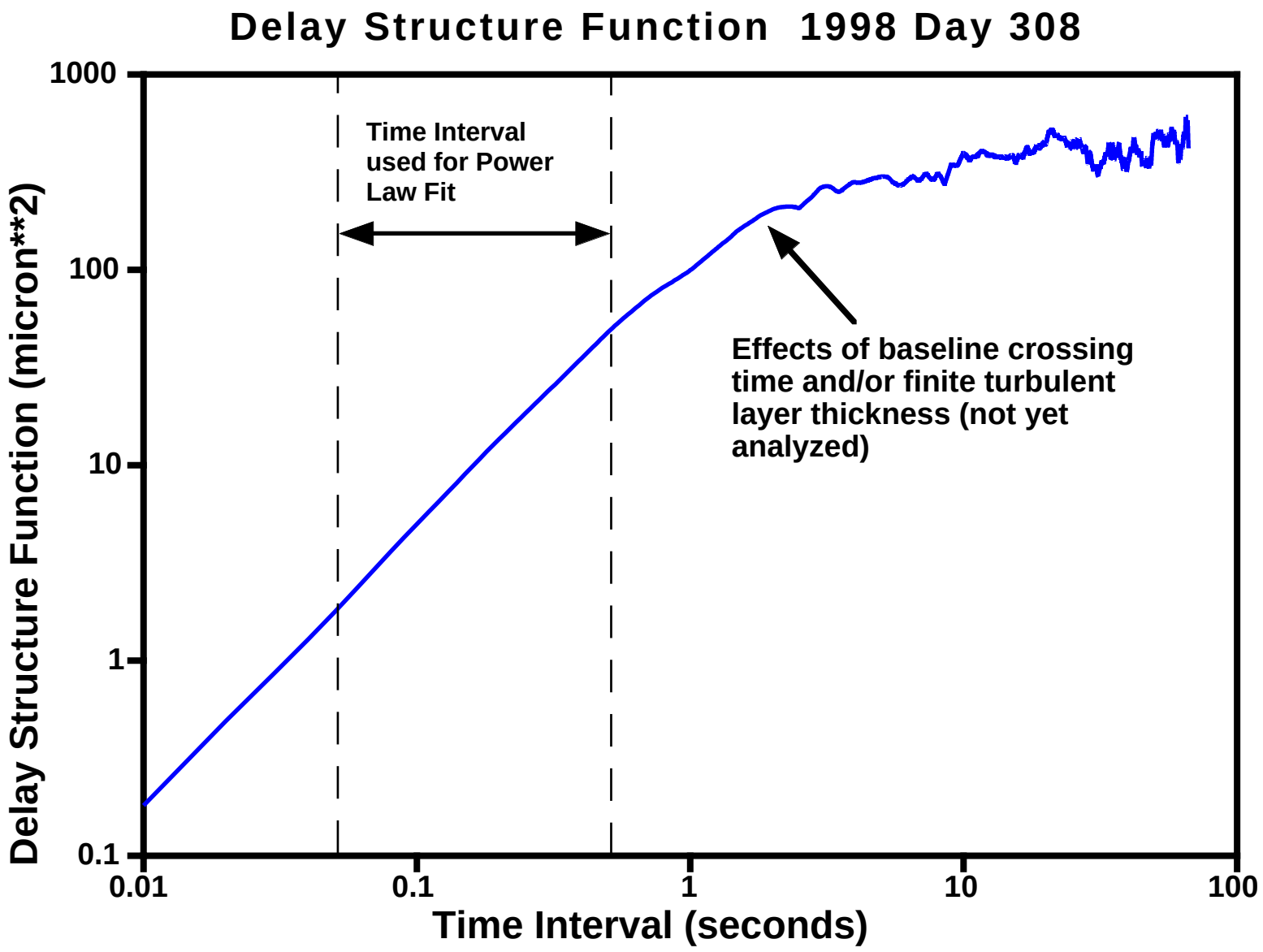
Added white light phases to delay line values ----> <u>total</u> phase/delay at 10 or 20 msec intervals

Subtracted a sidereal fit from all the data on each star for each night

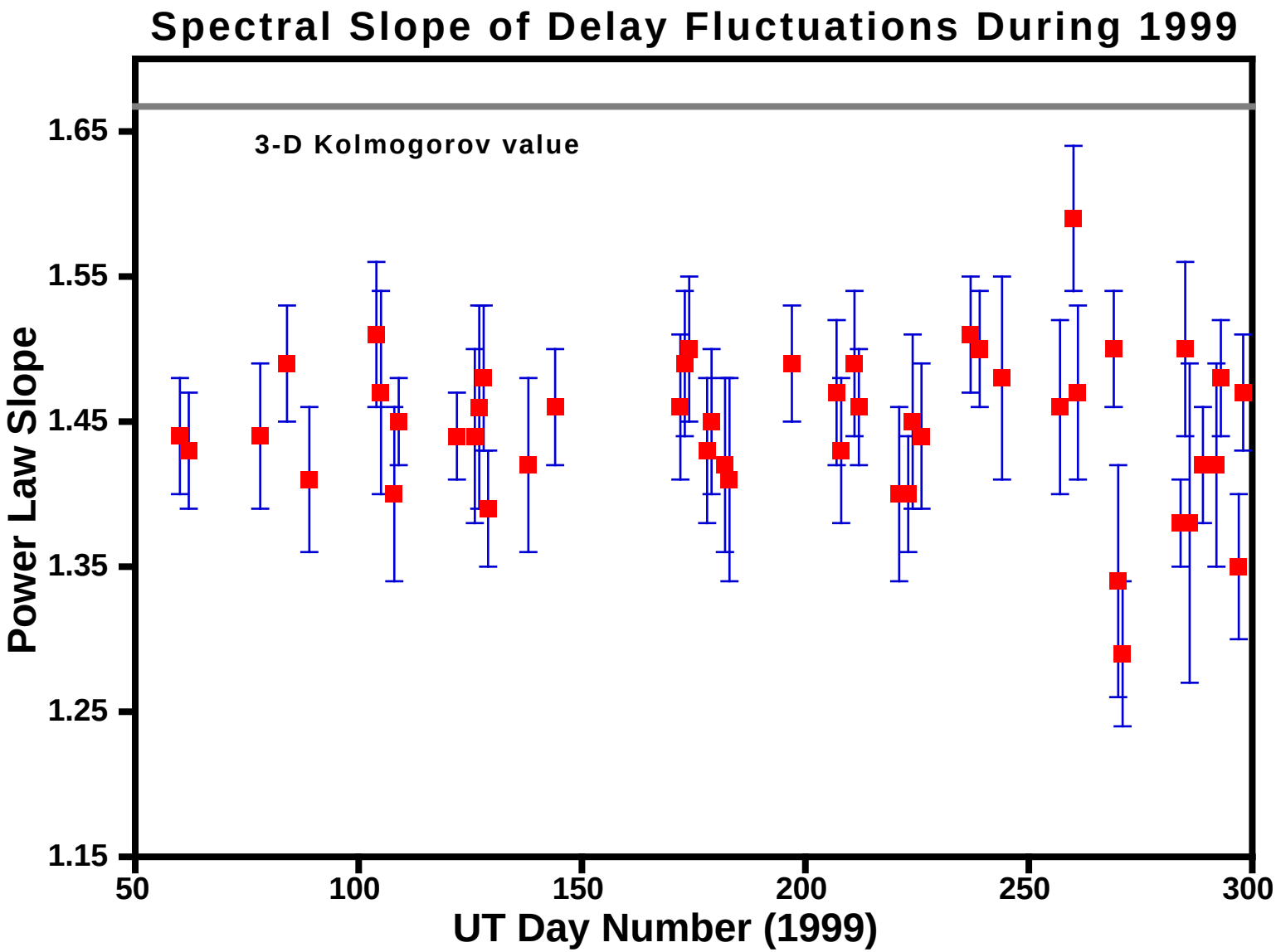
- **Calculated the structure function from these residual delays**

$$D_\tau(\Delta t) = \langle[\tau(t+\Delta t)-\tau(t)]^2\rangle$$

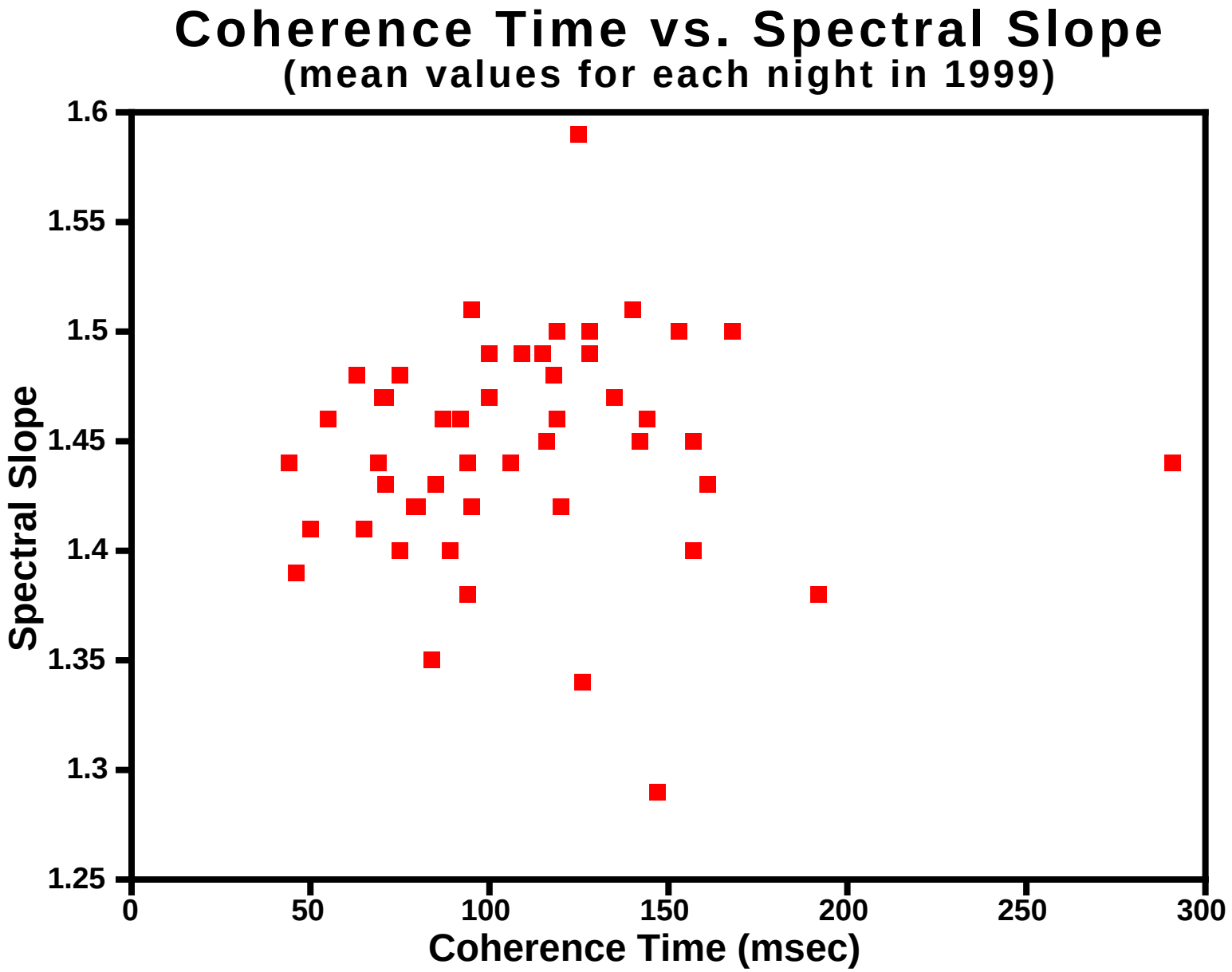
Attempt to calculate outer scale/turbulent layer thickness directly was not successful (switched to an easier problem first!)



Fitted parameters: Coherence time= 33 msec Slope = 1.43



Note: The error bars represent the 1 sigma scatter about the mean value for all the scans during one night


Coherence Time vs. Spectral Slope
(mean values for each night in 1999)
Spectral Slope
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
0
50
100
150
200
250
300
Coherence Time (msec)

Seeing (θ) vs. wavelength (λ)

for $D_\tau(\Delta t) = c(\Delta t)^\beta$

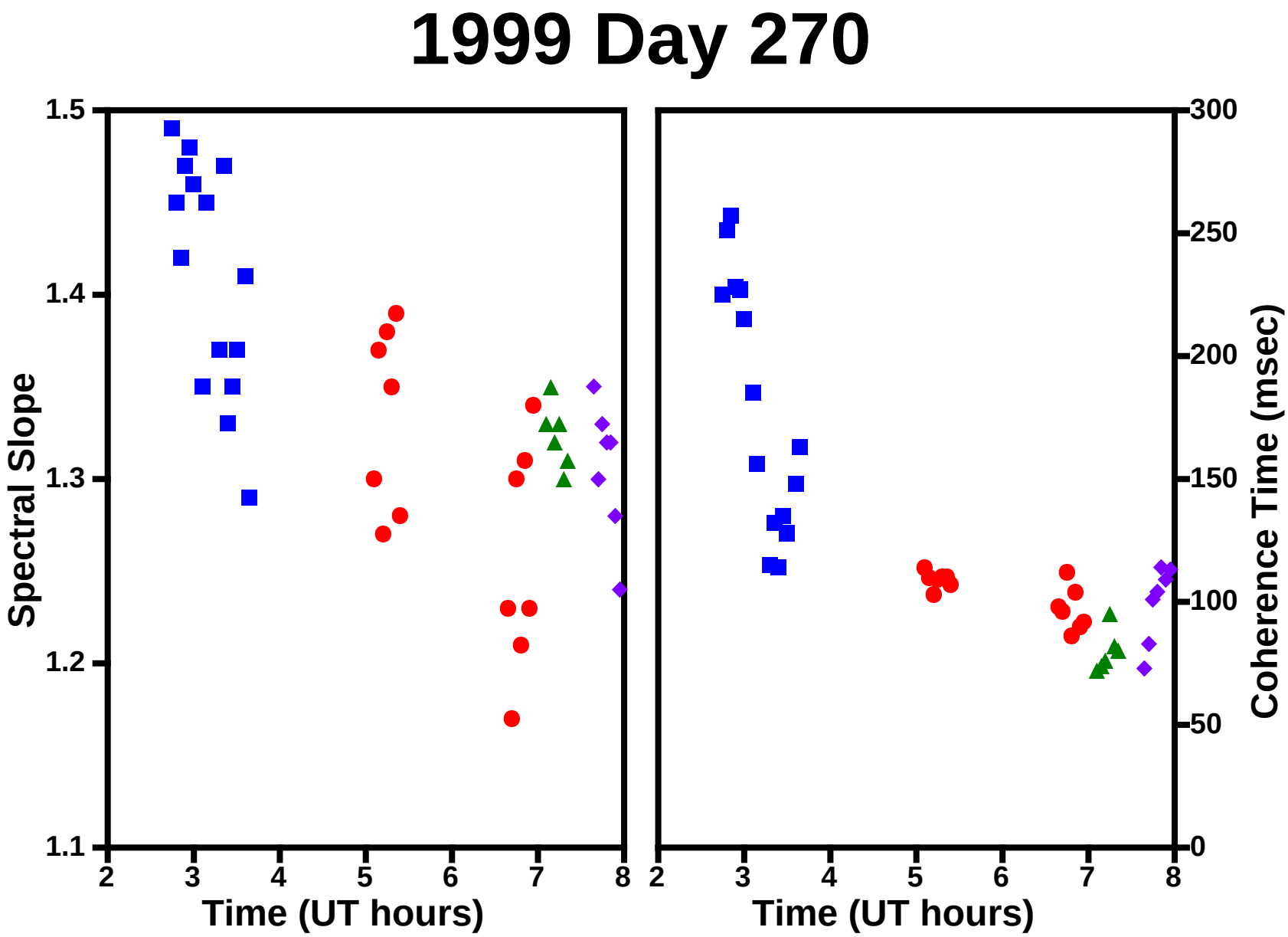
$$\theta = \theta_0 \lambda^{1-2/\beta}$$

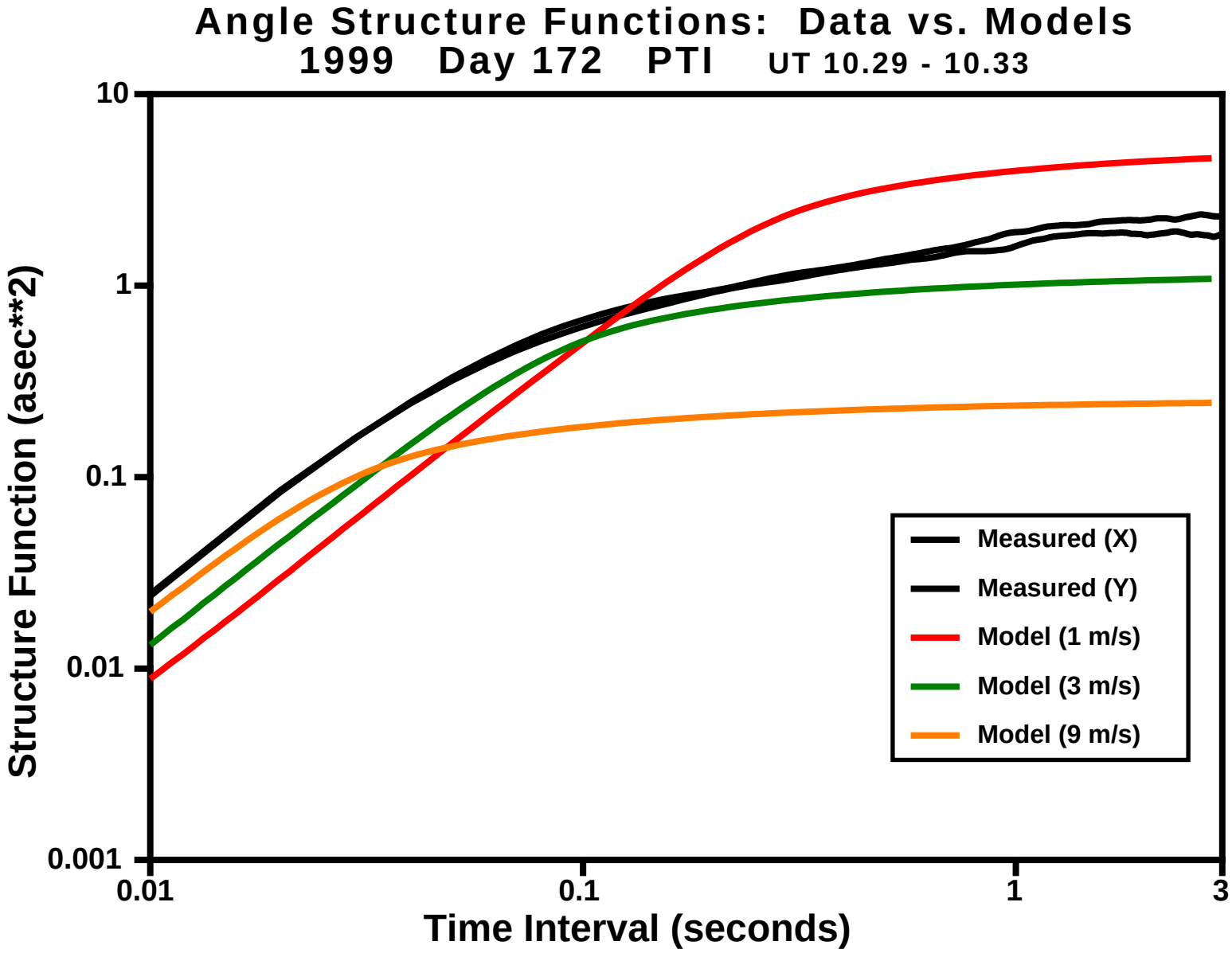
Kolmogorov spectrum (β=1.67) ------> $\theta = \theta_0 \lambda^{-0.2}$

favorable PTI spectrum (β=1.30) ----------> $\theta = \theta_0 \lambda^{-0.54}$

consistent with reports of superb seeing in the IR

(e.g. diffraction rings in 5 micron images from the Palomar 5 m telescope)


1999 Day 270
Spectral Slope
1.5
1.4
1.3
1.2
1.1
Time (UT hours)
2
3
4
5
6
7
8
Coherence Time (msec)
300
250
200
150
100
50
0



Note: The model calculations used the measured coherence time (48 msec) and spectral slope (1.39)

Derivation of r_0

Two aperture variance coherence time = 48 msec (at 2.2 microns)

One aperture variance coherence time = 79 msec

Fitted wind velocity = 3 m/s

Derived coherence length = 24 cm (2.2 microns) (1.0” seeing)

Implied coherence length at 650 nm = 4.2 cm (1.7” seeing)